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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

BROPHY, JAMIE LYNN

ART UNIT	PAPER NUMBER
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2822

DATE MAILED: 11/01/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/986,267

Applicant(s)

NGO ET AL.

Examiner

J. L. Brophy

Art Unit

2822

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 08 November 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-15 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2 and 4-15 is/are rejected.
- 7) ☒ Claim(s) 3 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 18 March 2002 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other:

DETAILED ACTION

This office action is in response to the application papers filed 11/8/01.

Drawings

Figure 1 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claim Objections

Claim 10 is objected to because of the following informalities: in line 2, "NH₄" should be "NH₃". Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1, 2, 4, 5, 7, 8, 11 and 13-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al (6,261,963) in view of Ritzdorf et al (Patent Application Pub. No. US 2002/0000271).

Zhao et al teach a method comprising forming an opening 220 in a dielectric layer 130, wherein the opening 220 is a dual damascene opening containing a lower via hole section in communication with an upper trench section, and wherein the dielectric layer 130 may be FTEOS (col. 4, lines 51-52);

Depositing a barrier layer 325A comprising tantalum or tantalum nitride or the like (Fig. 3 and col. 5, lines 22-27);

Depositing a seed layer 525B on the barrier layer (Fig. 5);

Depositing Cu or a Cu alloy 640 by electroplating (col. 5, lines 65-67) to fill the opening 220 to form an upper line in communication with an underlying via 140;

Thermal annealing the deposited Cu or Cu alloy 640 in NH_3 (col. 6, lines 40-45);
and

Conducting CMP such that an upper surface of the deposited Cu or Cu alloy 640 is substantially co-planar with an upper surface of the dielectric layer 130 (Fig. 7).

See Figs. 1-7 and accompanying text.

However, Zhao et al do not specifically teach a laser thermal anneal.

Ritzdorf et al teach a method that comprises applying a laser thermal anneal to a copper layer 440. See Figs. 2E, 2F and 15 and accompanying text.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method taught by Zhao et al by laser thermal annealing the copper layer because laser annealing is more precise than furnace annealing (see Ritzdorf et al, p. 7, paragraphs [0070] – [0071]).

Re claims 2 and 4, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to optimize and select an appropriate radiant fluence of the laser beam and a flow rate of the NH_3 . The selection of parameters such as energy, power, concentration, temperature, time, depth, thickness, etc., would have been obvious and involve routine optimization which has been held to be within the level of ordinary skill in the art. "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may be impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from results of prior art...such ranges are termed 'critical ranges' and the applicant has the burden of proving such criticality...More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation". *In Re Aller* 105 USPQ 233, 235 (CCPA 1955). See also MPEP 2144.05.

Claims 6 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al in view of Ritzdorf et al as applied to claims 1, 2, 4, 5, 7, 8, 11 and 13-15 above, and further in view of Cabral et al (EP 0751566).

Zhao et al in view of Ritzdorf et al teach a method that comprises annealing a Cu or Cu alloy layer in NH_3 with a laser anneal. In addition, Zhao et al teach a barrier layer lining the opening before deposition of the Cu or Cu alloy layer. Re claim 9, Zhao et al teach the step of conducting CMP such that an upper surface of the deposited Cu or Cu

alloy 640 is substantially co-planar with an upper surface of the dielectric layer 130 (Fig. 7).

However, Zhao et al in view of Ritzdorf et al do not teach that the barrier layer is a composite comprising a TaN layer on the dielectric layer, a layer of alpha-Ta on the TaN layer.

Cabral et al teach that the barrier layer 23 lining the opening in the dielectric layer 12 comprises a TaN layer on the dielectric layer, a layer of alpha-Ta on the TaN layer (col. 4, lines 47-49).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al by forming the barrier layer of TaN/alpha-Ta in order to decrease the resistivity (see Cabral et al, col. 7, lines 11-23). See, for example, Fig. 1.

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al in view of Ritzdorf et al as applied to claims 1, 2, 4, 5, 7, 8, 11 and 13-15 above, and further in view of Islam et al (6,174,810).

Zhao et al in view of Ritzdorf et al teach a method that comprises annealing a Cu or Cu alloy layer in NH_3 with a laser anneal.

However, Zhao et al in view of Ritzdorf et al do not teach the steps of treating the upper surface of the Cu or Cu alloy in a plasma containing NH_3 and depositing a SiN capping layer on the plasma treated surface by PECVD.

Islam et al teach the steps of treating the upper surface of the Cu or Cu alloy 38 in a plasma containing NH_3 and depositing a SiN capping layer 40 on the plasma treated surface by PECVD. See Fig. 2-3 and accompanying text.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al by treating the upper surface of the Cu or Cu alloy in a plasma containing NH_3 in order to remove copper oxide from the upper surface of the Cu or Cu alloy and improve the adhesion between the copper interconnect and the SiN capping layer (see Islam et al, col. 3, lines 37-60). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al by depositing a SiN capping layer on the copper interconnect surface by PECVD in order to prevent the copper from diffusing into adjacent layers (see Islam et al, col. 3, lines 24-29).

Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al in view of Ritzdorf et al and Cabral et al as applied to claims 6 and 9 above, and further in view of Islam et al.

Zhao et al in view of Ritzdorf et al and Cabral et al teach a method that comprises annealing a Cu or Cu alloy layer in NH_3 with a laser anneal, wherein the Cu or Cu alloy layer is surrounded by a TaN/ α -Ta barrier layer.

However, Zhao et al in view of Ritzdorf et al and Cabral et al do not teach the steps of treating the upper surface of the Cu or Cu alloy in a plasma containing NH_3 and depositing a SiN capping layer on the plasma treated surface by PECVD.

Islam et al teach the steps of treating the upper surface of the Cu or Cu alloy 38 in a plasma containing NH_3 and depositing a SiN capping layer 40 on the plasma treated surface by PECVD. See Fig. 2-3 and accompanying text.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al and Cabral et al by treating the upper surface of the Cu or Cu alloy in a plasma containing NH_3 in order to remove copper oxide from the upper surface of the Cu or Cu alloy and improve the adhesion between the copper interconnect and the SiN capping layer (see Islam et al, col. 3, lines 37-60). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al and Cabral et al by depositing a SiN capping layer on the copper interconnect surface by PECVD in order to prevent the copper from diffusing into adjacent layers (see Islam et al, col. 3, lines 24-29).

Allowable Subject Matter

Claim 3 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

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The following is an examiner's statement of reasons for allowance: none of the references of record teach all of the process limitations as claimed. Specifically, none of the references teach a method that comprises annealing to heat the Cu or Cu alloy to a temperature of about 983°C to 1183°C, in combination with the other claim limitations.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to J. L. Brophy whose telephone number is (703) 308-6182. The examiner can normally be reached on M-F (8:00-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (703) 308-4905. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9318 for regular communications and (703) 872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

J. L. B.

jlb

October 24, 2002


AMIR ZARABIAN
SUPERVISORY PATENT EXAMINER
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